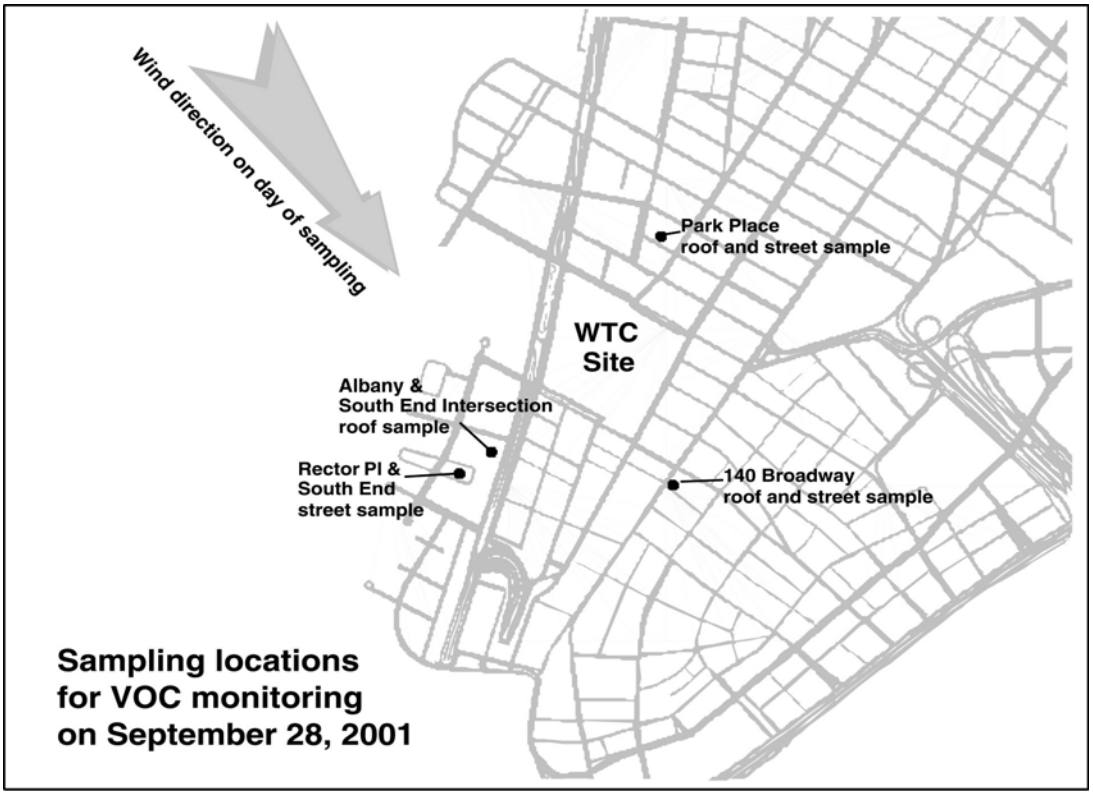
VOC MONITORING NEAR THE WORLD TRADE CENTER ON SEPTEMBER 28, 2001
SUMMARY

To measure the surrounding communities' exposure to volatile organic compounds (VOCs) from the World Trade Center fires and cleanup activities, the State and City Health Departments collected air samples for some VOCs around the World Trade Center. Most of these compounds are commonly found in petroleum products or are common industrial chemicals. Some of these compounds are also produced by fires, including the World Trade Center fires, or by equipment, such as the equipment being used in the recovery effort.

Air samples were taken on September 28, 2001 at three locations around the World Trade Center site. Samples were taken at roof level and street level. They were taken in the morning, afternoon and evening. One sample was also taken in the smoke at the wreckage at the World Trade Center. The sample in the smoke plume had the highest levels of VOCs. Recovery and emergency workers need to take safety measures that have been provided to them to limit their exposure to the smoke at the site.

Samples were taken near Parc Place, Rector Place and Broadway at Liberty Streets. Upwind of the site and crosswind, levels of VOCs were about the same as those commonly found in outdoor samples (also called "background" levels). Downwind of the site, VOC levels for most of the compounds detected were higher than background.

The higher levels of VOC compounds downwind of the site are not likely to last for an extended period of time (for example, the fires will be put out and the wind direction changes). The health risks from VOCs downwind, where the levels are highest, are still not much different than they would be for typical background levels. For the VOCs that were measured, the air concentrations outside the work area are not a significant health concern. However, other chemicals from the fires or other recovery activities may be contributing to eye, nose and throat irritation.



VOC Monitoring Near the World Trade Center Site
New York State Department of Health
September 28, 2001

On September 28, 2001, New York State Department of Health (NYSDOH) and New York City Department of Health (NYCDOH) collected air samples at three locations north, southwest and southeast of the World Trade Center to measure community exposure levels to a limited number of VOCs. The locations were selected to represent the communities closest to the site that are currently occupied or might be expected to be re-occupied soon. The primary purpose was for screening, i.e. to determine whether additional VOC sampling in the surrounding community is warranted on some regular basis.

The air samples were collected in Summa canisters over two hours at three locations, and a grab sample was taken on the rubble pile (see table below). The Summa canisters were returned to NYSDOH Wadsworth Laboratories for analysis by gas chromatography – mass spectrometry (GC-MS) following EPA method TO-14.

Location	Elevation	Time*
75 Park Place	roof above 14th floor	M, A, E
(Park Place and	10th floor balcony	M, A
Greenwich St.)	street	M, A, E
Parc Place at	roof above 24th floor	M, A, E
225 Rector	street	M, A, E
140 Broadway	roof above 52nd floor	M, A, E
(Broadway and	street	M, A, E
Liberty)		
Top of rubble		8PM**

* M - morning (~6-8AM)
A - afternoon (~2-4PM)
E - evening (~6-8PM)

** Grab sample
(~25 seconds)

The day began sunny but became cloudy as the day progressed. A light rain started just before the evening sampling and was intermittent throughout that sampling period. Light winds were primarily from the north but shifted somewhat between the northeast and northwest throughout the day.

Environmental Results and Conclusions

1. The air sample collected in the smoke plume on the WTC debris pile contained the highest levels of VOCs. VOCs with the highest levels were acetone and a number of fuel components or products of combustion, i.e. benzene, toluene, ethylbenzene, styrene and chloromethane. None of the reported levels were unusually high compared to samples from other fires (P.S.J. Lees, 1995). These sample results are generally consistent with similar

samples of the smoke plume taken on several occasions by the US Environmental Protection Agency. However, the benzene concentrations were not as high (in absolute terms or relative to toluene and xylene) as most of the EPA sampling results.

2. At 75 Park Place (upwind of the WTC site) and at 225 Rector (cross-wind), VOC levels, except ethanol, were generally in the range of levels commonly found in outdoor air samples (background). At 140 Broadway (downwind), where the smoke plume from the WTC site was visible during each of the sampling events, most of the VOCs detected were greater than background (generally less than five times background levels and all (except trichlorofluoromethane) less than about ten times background levels).

3. Generally, VOC concentrations at 140 Broadway were about 3 times greater than those at Park Place and Rector Place sites.

4. During each of the sampling events, the smoke plume was visibly evident at 140 Broadway and fire odors were noticeable at the street level. During sampling at the other sites, the smoke plume was not visibly evident at the sites. WTC-related odors were sometimes noticed at the Rector Place site and not noticed at the Park Place site.

5. VOC concentrations on the roofs were not substantially different from street-level VOC concentrations at each of the sampling sites, including 140 Broadway (53 stories high).

6. Concentrations of VOCs associated with the smoke plume were about 20 times greater in the grab sample at the pile than at 140 Broadway.

7. High levels of trichlorofluoromethane (a refrigerant, R-11), were observed in the samples from the roof at 140 Broadway. The building manager said that a chiller leak sensor had detected a minor refrigerant leak of R-11 on Friday (Sept 28) morning. The problem was corrected later in the day. The chiller is located on the 52nd floor and a mechanical room vent was about three meters (10 feet) from the sampler.

8. Elevated methylene chloride concentrations were also detected on the roof of 140 Broadway with slightly higher levels found in the afternoon sample when the chiller was being repaired. Methylene chloride is commonly used as a degreaser in building HVAC (heating, ventilation and air conditioning) system maintenance and repair work. It was not measureable in the plume sample or any of the other samples.

9. The field forms for the morning samples for 140 Broadway (roof and street level) were accidentally switched so the laboratory report forms misidentified the roof and street level samples at this location.

10. Because the trichlorofluoromethane and methylene chloride were on the roof top and people are not being directly exposed to them, they are not discussed in the health implications section.

11. Assuming that the fires and smoke will continue to diminish as the recovery work progresses,

these data suggest that additional VOC sampling for these compounds is not necessary. However, it may be useful to confirm these findings, to assess levels of other volatile compounds such as known respiratory irritants and to assess VOC concentrations once the fires are controlled to ensure that other recovery activities are not a continuing source of VOCs in the community.

Data Limitations

These VOCs were selected for analysis because they are commonly found at low levels in outdoor and indoor air, routine analytical procedures were readily available and many have been found in smoke. Other VOCs and semivolatile organic compounds have been found in the smoke from fires and can be expected near the site and in the smoke plume as well. Different sampling and analytical techniques are required for these compounds.

Public Health Implications

Although the highest levels of VOCs were found in samples from the plume at the WTC debris pile, these results are not likely to represent the potential exposure of the residents. Residents are unlikely to be in the plume at the debris pile where they could be exposed to these levels for any length of time. Therefore, the sampling results for areas potentially affected by the plume (i.e., at downwind locations) but not at the debris pile are more relevant for evaluating potential exposure to the residents. The levels of some of the chemicals in the plume measured at the debris are elevated and exceed typical background ranges, and recovery and emergency workers should take precautions to limit their exposure to emissions from the plume.

The levels of VOCs at the upwind sites (75 Park Place and 225 Rector) are generally within the range of typical background levels.

The air concentrations of VOCs at the downwind site (140 Broadway) were generally greater than those measured upwind (75 Park Place and 225 Rector) and typical background concentrations. However, none of the WTC-related chemicals measured at 140 Broadway exceed both typical background levels and air comparison values except benzene, chloromethane and styrene.

None of the chemicals detected above background at 140 Broadway exceed intermediate or short-term air comparison values except benzene. The average and highest levels of benzene at 140 Broadway are slightly above typical background and are near the intermediate comparison value for this chemical. This comparison value for benzene is about 90 times lower than the exposure level that caused mild neurological effects in mice exposed regularly for 30 days.

The benzene air concentrations at 140 Broadway (as well as typical background concentrations of benzene) exceed the health comparison value for benzene in air based on carcinogenic effects following long-term exposure. The cancer comparison value is the air concentration associated with an increased lifetime cancer risk of one-in-one million (10^{-6}). Because the estimated duration of exposure is at most one year, and because elevated levels are unlikely to persist for

extended periods of time (e.g. the fires will be put out and the wind direction will periodically change), community exposures are not expected to result in cancer risks that are appreciably increased over those resulting from background exposure. These estimated cancer risks do not exceed one-in-ten thousand (10^{-4}), above which actions are usually taken to reduce exposure.

The average levels of chloromethane and styrene also exceed background and their air comparison values based on cancer effects and long-term exposure. Again, based on the low potential for long-term exposure to elevated levels, this is not expected to result in an appreciable increased cancer risk, but one similar to the risks resulting from exposure to background levels.

Limitations of Health Assessment

The primary limitation of this assessment is that the list of VOCs measured may not be completely representative of the emissions from the fires and recovery activities at the World Trade Center site. The analytical methods did not include all of the numerous combustion products that can be generated from the fires, which, in addition to the measured VOCs, could affect air quality and public health. Some chemicals that are known to be produced by fires (e.g. aldehydes, acrolein) and that are strong respiratory irritants were not measured.

When odors are present, it is not unusual for some people to experience short-term effects such as respiratory irritation and effects such as headaches and dizziness. These effects tend to diminish once exposure to the odors is stopped, and usually do not result in long-term health consequences. Some people are more likely to experience these effects than others.

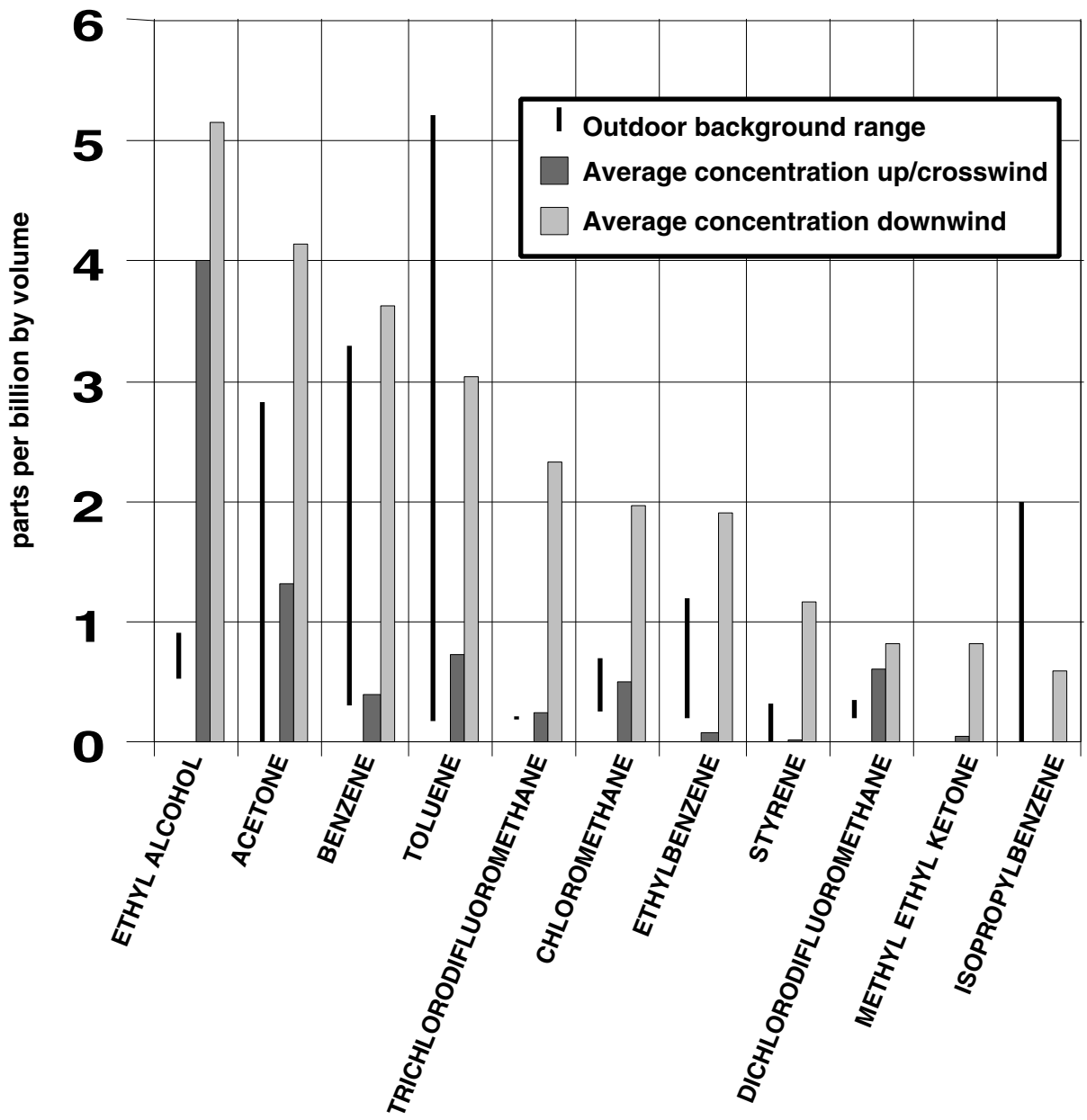
Conclusion

The results of the monitoring suggest that the levels of some VOCs in the plume at the debris pile are significantly elevated above typical background levels, and workers at the site should take precautions to limit their exposure. For the VOCs that were measured, the air concentrations outside the work area are not a significant health concern. However, the elevation above background levels of some VOCs indicates that combustion products may be contributing to symptoms of eye, nose and throat irritation that have been reported in workers and residents in the WTC neighborhood. Based on the current results and the expected mitigation of VOC emissions from the site in the future by controlling the fires, continued monitoring for the VOCs sampled is not necessary at this time. However, it may be useful to confirm these findings, to assess levels of other volatile compounds such as known respiratory irritants and to assess VOC concentrations once the fires are controlled to ensure that other recovery activities are not a continuing source of VOCs in the community.

References

Peter S.J. Lees. 1995. Combustion products and other firefighter exposures: A state of the art review. Occup. Med. 10:691-706.

VOC's Detected on September 28, 2001
Near the World Trade Center Site



Notes:

- Results are reported as the average concentration in a 2-hour sample.
- Since wind direction changes, what is upwind on one day may be downwind on another.
- Background levels are from the EPA and NYSDOH databases and indicate "typical outdoor levels".
- Detailed sample results appear as a full table on the next page.

Summary of Outdoor Air Samples Collected at the World Trade Center Disaster Area
28 September 2001
All Results are Parts Per Billion by Volume

Analyte	75 Park Place								Parc Place at 225 Rector						140 Broadway						N Tower Plume	Outdoor Background[3]	
	Roof Above 14th Floor			10th Floor		Street			Roof Above 24th Floor			Street			Roof Above 52nd Floor			Street					
	M	A	E	M	A	M	A	E	M	A	E	M	A	E	M	A	E	M	A	E	8PM	EPA[1]	NYSDOH[2]
DICHLORODIFLUOROMETHANE	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.8	1.1	1.1	0.8	0.6	0.7	1.2	0.32 - 0.35	<0.2
CHLOROMETHANE	1.0 PL	1.0 PL	1.0 PL	1.0 PL	1.0 PL	1.0 PL	1.0 PL	1.0 PL	1.0 PL	1.0 PL	1.0 PL	1.0 PL	1.0 PL	1.0 PL	2.8	1.2	1.0 PL	3.2	2.4	1.7	58	0.6 - 0.7	0.24 - 0.63
BROMOMETHANE	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	3.9	0.05 - 3.1	<0.3
CHLOROETHANE	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	2.7	NA	<0.2
ETHYL ALCOHOL	4.7	1.9	3.6	3.5	4.1	10.1	9.6	4.7	2.6	2.1	3.8	2.1	1.3	2.0	3.7	5.0	4.3	9.6	3.7	4.6	32	NA	<0.5 - 0.9
TRICHLOROFLUOROMETHANE	0.4 PL	0.4 PL	0.4 PL	0.4 PL	0.4 PL	0.4	0.4	0.4	0.4 PL	0.4 PL	0.4 PL	0.4 PL	0.4 PL	0.4 PL	>133	>133	>133	4.8	0.6	1.6	1.7	0.19 - 0.21	<0.18
ISOPRENE	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	2.5	NA	NA
ACETONE	1.3	0.9	1.1	1.4	2.2	1.2	1.5	1.3	1.2	1.0	1.7	1.4	1.0	1.2	4.0	7.6	4.6	3.2	2.9	2.6	59	ND - 2.83	NA
METHYLENE CHLORIDE	0.6 PL	<0.6	<0.6	0.6 PL	0.6 PL	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	2.2	8.4	3.2	<0.6	0.6 PL	<0.6	0.6 PL	0.3 - 1.8	0.14 - 1.1
METHYL-tert-BUTYL ETHER	0.6 PL	0.6 PL	0.6 PL	0.6 PL	0.6 PL	1.2	0.6 PL	0.8	0.6 PL	0.6	1.4	0.6 PL	0.6 PL	0.6 PL	0.6 PL	0.6 PL	0.6 PL	0.6 PL	0.6	0.6 PL	0.6 PL	NA	<0.3
n-HEXANE	0.6 PL	<0.6	<0.6	0.6 PL	0.6 PL	0.6 PL	<0.6	2.3	0.6 PL	<0.6	0.6 PL	<0.6	<0.6	<0.6	0.6 PL	0.6 PL	<0.6	0.6 PL	0.6 PL	0.6 PL	3.7	0.83 - 2.95	0.1 - 0.5
METHYL ELTHYL KETONE	<0.7	<0.7	<0.7	<0.7	0.7 PL	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	0.7 PL	<0.7	<0.7	1.0	1.3	0.8	0.7	0.7	0.7 PL	25	ND	NA
TETRAHYDROFURAN	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	0.7 PL	<0.7	<0.7	<0.7	<0.7	<0.7	3.4	NA	NA
n-HEPTANE	<0.5	<0.5	<0.5	<0.5	0.5 PL	<0.5	0.5 PL	<0.5	<0.5	<0.5	0.5 PL	<0.5	<0.5	<0.5	0.5 PL	<0.5	<0.5	0.5 PL	0.5 PL	0.5 PL	3.4	0.35 - 0.62	NA
BENZENE	0.7 PL	0.7 PL	0.7 PL	0.7 PL	0.7 PL	0.7 PL	0.7 PL	0.7 PL	0.7 PL	0.7 PL	1.0	0.7 PL	0.7 PL	0.7 PL	5.0	2.2	0.7	5.7	5.0	3.1	88	0.6 - 3.3	0.3 - 1.5
METHYLMETHACRYLATE	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5 PL	<0.5	<0.5	0.5 PL	0.5 PL	0.5 PL	13	NA	NA
METHYL ISOBUTYL KETONE	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7	NA	NA
n-OCTANE	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.4 PL	<0.4	<0.4	<0.4	0.4 PL	<0.4	2.4	0.16 - 0.76	NA
TOLUENE	0.7	0.5 PL	0.5 PL	0.8	2.0	1.1	0.7	1.2	0.5 PL	0.5 PL	1.3	0.6	0.5 PL	0.5	4.0	2.7	1.2	4.2	3.7	2.5	64	0.16 - 5.21	0.3 - 1.5
TETRACHLOROETHENE	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.4 PL	<0.4	<0.4	1.5	0.4 PL	<0.4	0.1 - 0.9	0.1 - 0.5
n-NONANE	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.4 PL	<0.4	<0.4	0.4 PL	0.4 PL	<0.4	3.2	0.14 - 0.61	NA
CHLOROBENZENE	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.4 PL	<0.4	<0.4	0.4 PL	0.4 PL	<0.4	1.1	ND - 0.31	<0.4
ETHYLBENZENE	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5 PL	<0.5	0.5 PL	0.5	<0.5	<0.5	<0.5	3.0	0.9	0.5 PL	3.2	2.5	1.6	46	0.2 - 1.2	0.1 - 0.6
M,P-XYLENE	<0.5	<0.5	<0.5	<0.5	0.5 PL	0.5 PL	0.5 PL	0.5 PL	<0.5	0.5 PL	0.5 PL	0.5 PL	<0.5	<0.5	0.5 PL	<0.5	<0.5	0.5 PL	0.5 PL	0.5 PL	3.2	1.0 - 6.5	0.2 - 1.2
O-XYLENE	<0.5	<0.5	<0.5	<0.5	<0.5	0.5 PL	<0.5	0.5 PL	<0.5	<0.5	0.5 PL	<0.5	<0.5	<0.5	0.5 PL	<0.5	<0.5	0.5 PL	0.5 PL	0.5 PL	6.5	0.2 - 1.5	0.2 - 1.1
STYRENE	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5 PL	<0.5	<0.5	<0.5	1.9	0.5 PL	<0.5	1.9	1.8	1.1	75	ND - 0.31	<0.24
ALPHA-PINENE	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.4	0.023 - 0.264	NA
ISOPROPYLBENZENE	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	1.1	0.4 PL	<0.4	0.9	0.9	0.5	13	ND	<2.0
n-DECANE	<0.3	<0.3	<0.3	<0.3	<0.3	0.3 PL	0.3 PL	<0.3	<0.3	<0.3	<0.3	0.3 PL	<0.3	<0.3	0.3 PL	<0.3	<0.3	0.3 PL	0.3 PL	0.3 PL	2.6	0.05 - 0.68	NA
n-PROPYLBENZENE	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.4 PL	<0.4	<0.4	<0.4	<0.4	<0.4	2.5	0.08 - 0.26	<2.0
1,3,5-TRIMETHYLBENZENE	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	2.0	0.04 - 0.51	<0.2
1,2,4-TRIMETHYLBENZENE	<0.4	<0.4	<0.4	<0.4	<0.4	0.4 PL	<0.4	<0.4	<0.4	<0.4	0.4 PL	<0.4	<0.4	<0.4	0.4 PL	0.4 PL	<0.4	0.4 PL	0.4 PL	<0.4	2.9	0.57 - 1.51	<0.2
d-LIMONENE	<0.4	<0.4	<0.4	<0.4	<0.4	0.4 PL	<0.4	<0.4	<0.4	0.4 PL	0.4	<0.4	<0.4	<0.4	0.4	0.4	0.4 PL	<0.4	<0.4	<0.4	0.6	NA	NA
1,2,3-TRIMETHYLBENZENE	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	1.4	NA	NA
1,4-DICHLOROBENZENE	<0.5	<0.5	<0.5	<0.5	<0.5	0.5 PL	1.0	0.5 PL	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	ND - 0.2	0.1 - 0.6
n-UNDECANE	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.3 PL	<0.3	<0.3	0.3 PL	0.3 PL	<0.3	2.9	ND - 0.62	NA
n-BUTYLBENZENE	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.0	ND	<1.8
n-DODECANE	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.3 PL	<0.3	<0.3	0.3 PL	0.3 PL	<0.3	3.7	ND - 0.41	NA

M - morning (~6-8AM)
A - afternoon (~2-4PM)
E - evening (~6-8PM)

NA - Not Available
ND - Not Detected

Samples were collected by Summa canisters (EPA Method TO-14) for a 2-hour period, the plume sample was a 25 second grab sample. Samples were analyzed by the Wadsworth Center for Labs and Research.

[1]The United States Environmental Protection Agency Volatile Organic Compounds Database (EPA) is a compilation of indoor and outdoor data from studies across the United States published in 1988.

[2]The New York State Department of Health Database (NYSDOH) is a summary of indoor and outdoor air sample results in control homes collected and analyzed by the NYSDOH from 1989 through 1996.

[3]The levels are the 25th percentile to 75th percentile, (middle half), of the data from the EPA and NYSDOH databases.

< Means less than. The number following this symbol (<) is the lowest level the laboratory test can reliably measure (detection limit). If there is a "<" before any number, then the chemical was NOT detected in the sample.

[PL] - Present, but less than the level indicated.

For the graph on the previous page, average concentrations were calculated using 0 if not detected (<DL) and DL/2 if present but less than the detection limit (DL PL). Downwind average includes all values at Broadway. Upwind/crosswind average includes all values from Park Place and Rector.